

IMPACTS

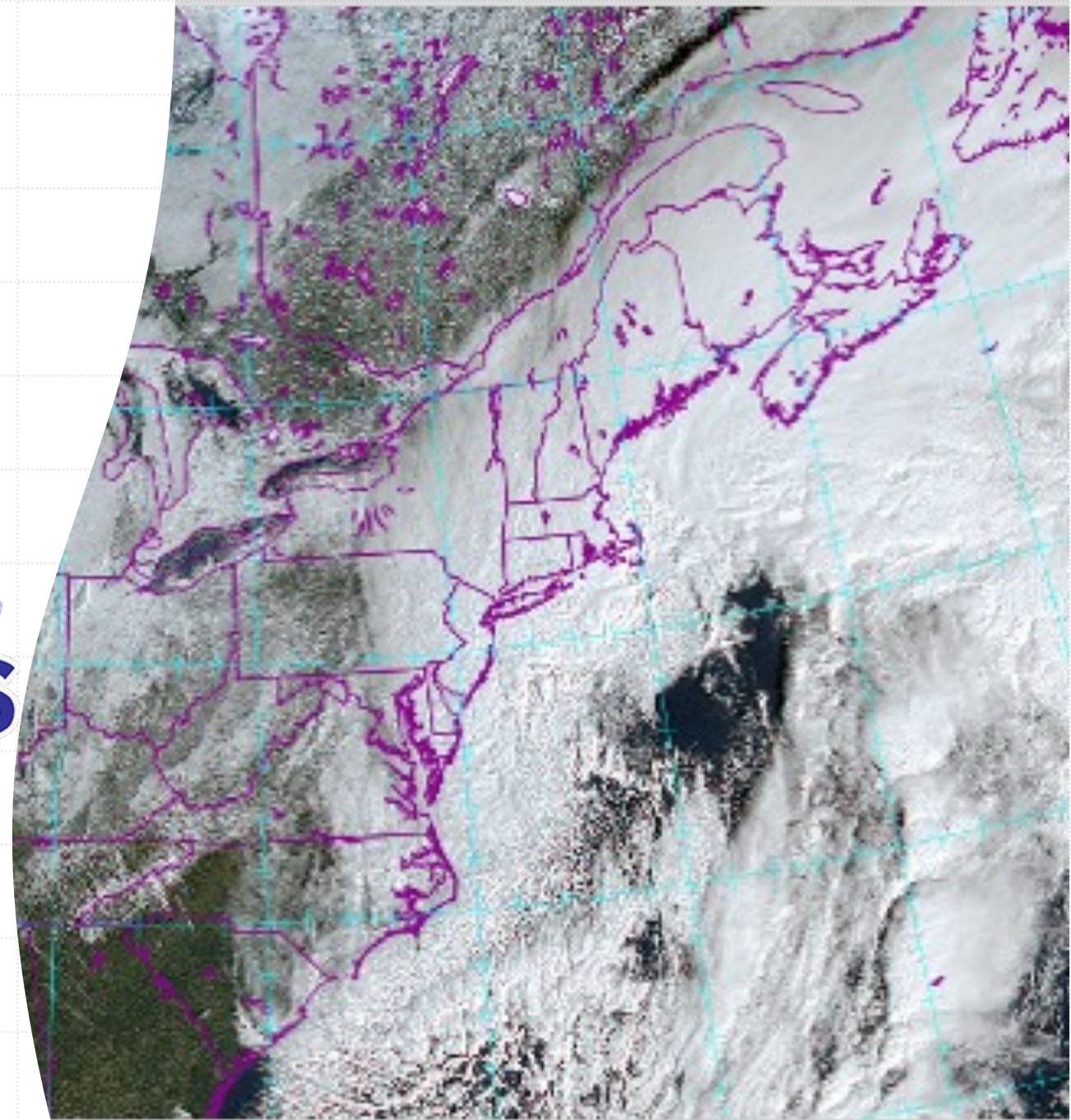
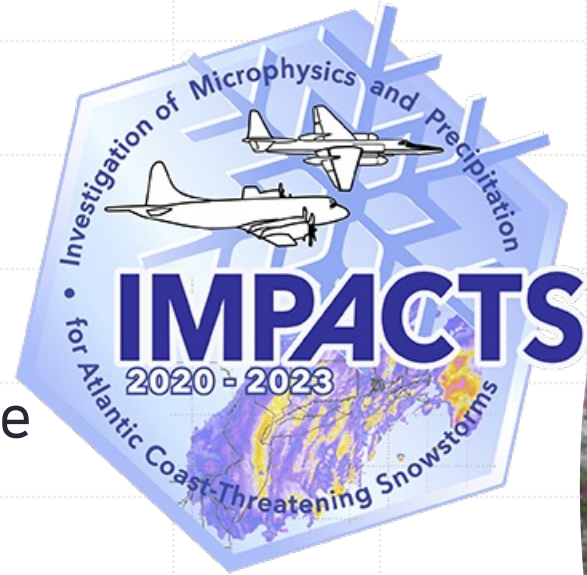
Coordination with WINTRE-MIX

Lynn McMurdie
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WINTRE-MIX

Collaborators:

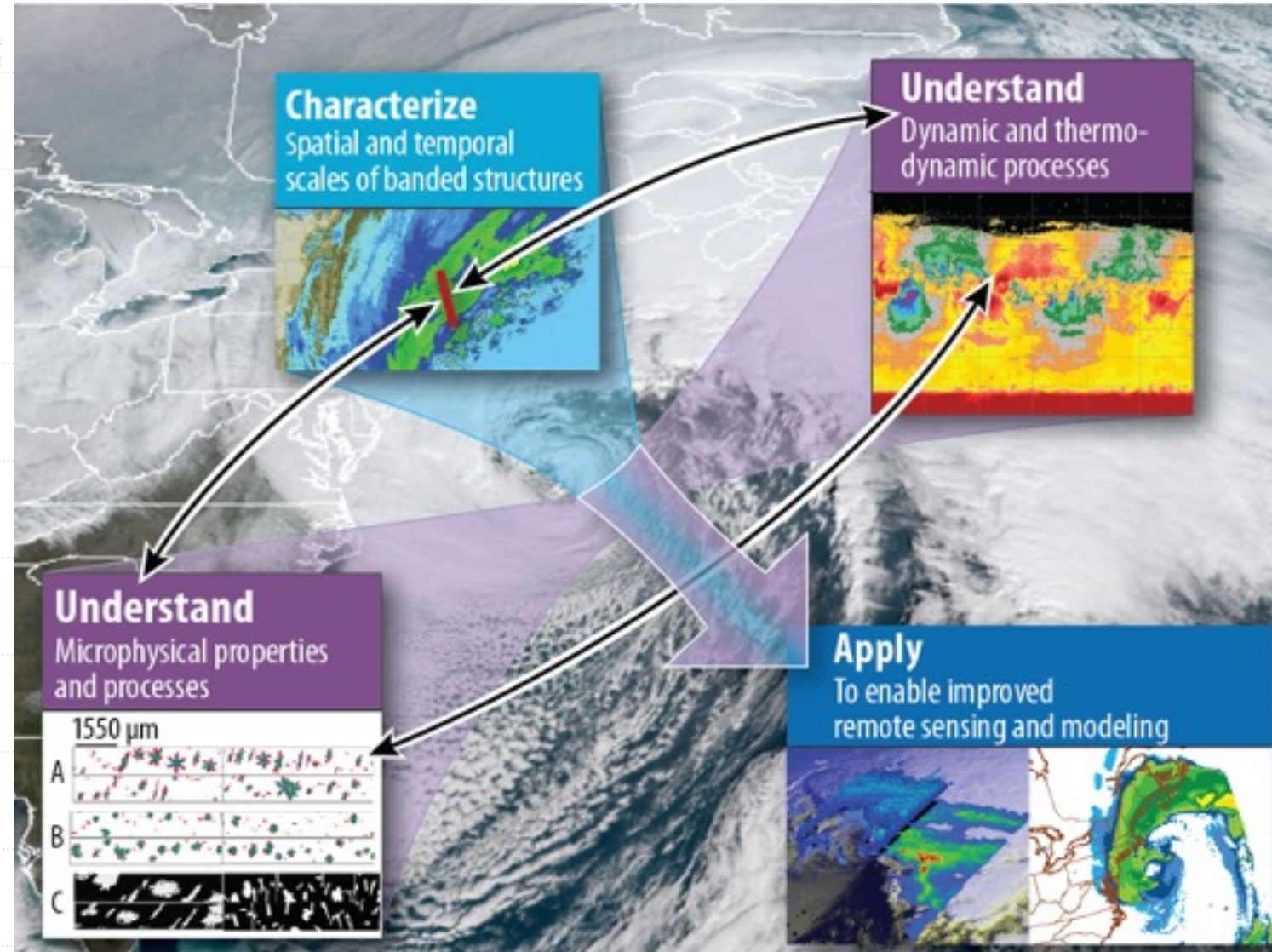
Mathieu Lachapelle
Julie Thériault
Robert Crawford
Daniel Michelson
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Overview and Science Goals

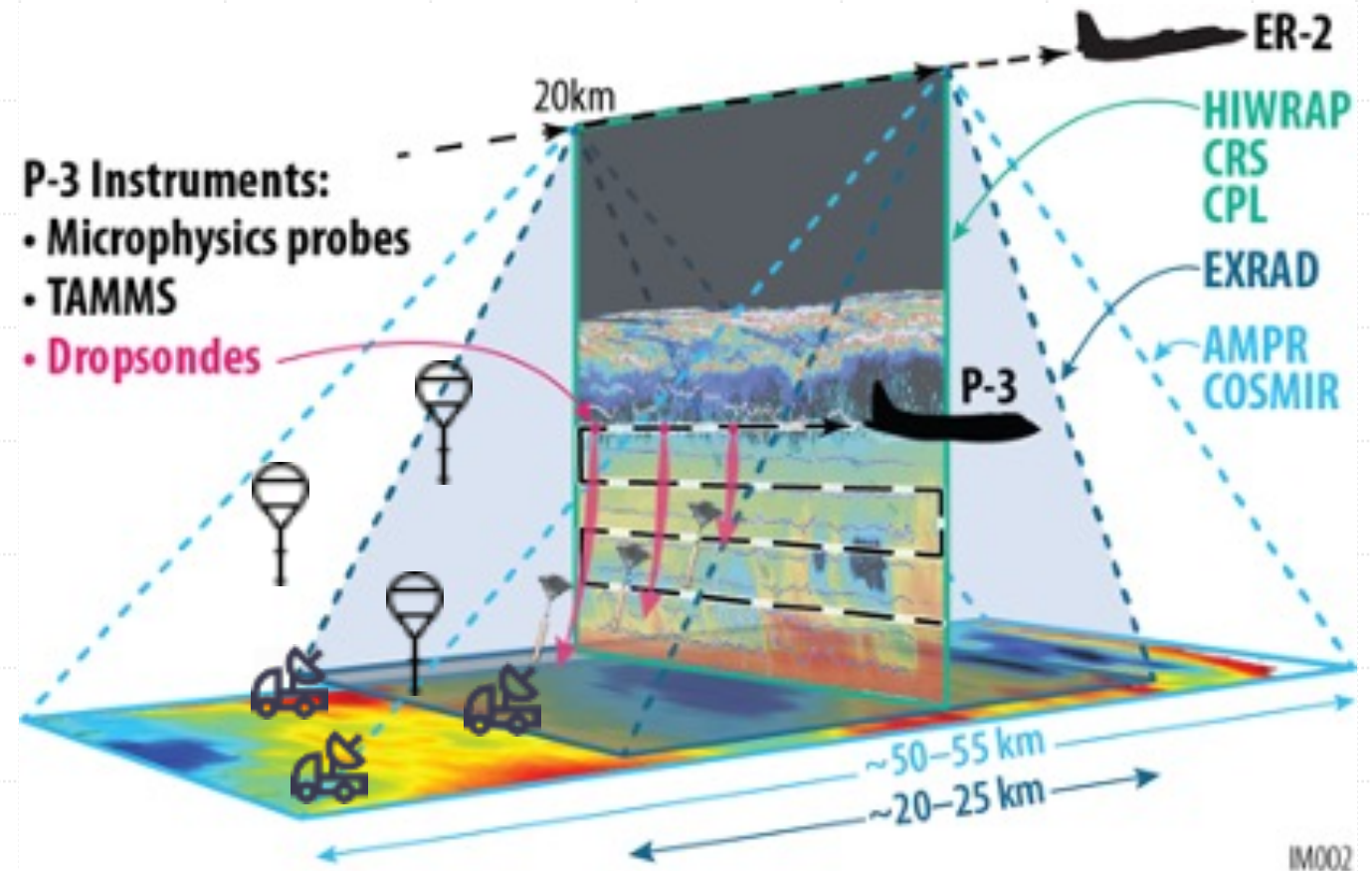
- Investigation of Microphysics and Precipitation in Atlantic-Coast Threatening Snowstorms is an ongoing NASA field campaign to study snowstorms
- Three deployments Jan-Feb 2020, 2022, and 2023
- In 2022 we overlapped with WINTRE-MIX during February 2022
- Science Goals: Characterize and understand snowband structures, apply knowledge to improving remote sensing and modeling



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Observational Strategy

- **ER-2**: Satellite simulating aircraft with remote sensing instrumentation flies above storm clouds
- **P-3**: In situ aircraft with microphysics probes, TAMMS and dropsondes flies at different altitudes within clouds
- **Ground**: Radiosonde launches, NY mesonet observations, mobile ground radars and multiple radar instruments at SUNY Stony Brook/Brookhaven



From McMurdie et al. 2022

IMPACTS: Aircraft Instruments

- **ER-2**: Remote Sensing instruments
 - Radiometers
 - **AMPR** = Advanced Microwave Precipitation Radiometer, cross-track scanning 10, 19, 37 85 GHz
 - **CoSMIR** = Conical Scanning millimeter-wave Imaging Radiometer, conical and cross-track 50, 89, 165, 183 GHz
 - Radars
 - **CRS** = Cloud Radar System, W-band
 - **HIWRAP** = High-altitude Imaging Wind and Rain Airborne Profiler, Ka- and Ku-band, nadir pointing
 - **EXRAD** = ER-2 X-band Doppler Radar, X-band, nadir and conical scanning
 - **CPL** = Cloud Physics Lidar, attenuated backscatter at 355, 532, 1064 nm, volume depolarization ratio at 1064 nm
 - **LIP** = Lightning Instrument Package

IMPACTS: Aircraft Instruments

- **P-3**: In situ instruments
 - Cloud Probes
 - **CDP** – Cloud Droplet Probe: particle sizes 2–50 μm
 - **2DS** – 2D Stereo probe: particle sizes 10 μm – 3 mm
 - **HVPS** – High Volume Precipitation Spectrometer: particle sizes 150 μm – 10 cm
 - **WCM-3000** – cloud liquid and total condensate up to 2 g m⁻³
 - **King** – liquid water probe
 - **Hawkeye** (Fast CDP, 2DS, CPI)
 - **RICE** – Rosemont Icing Detector – supercooled liquid water
 - **WISPER** – Water Isotope system for Precipitation and Entrainment research – total ice measurements
 - **PHIPS** – Particle Habit Imaging and Polar Scattering
 - **TAMMS** – Turbulent Air Motion Measurement Systems – 3-d winds
 - **AVAPS** – Advanced Vertical Atmospheric Profiling System (AVAPS) – dropsondes

We flew 11 storms in 2022

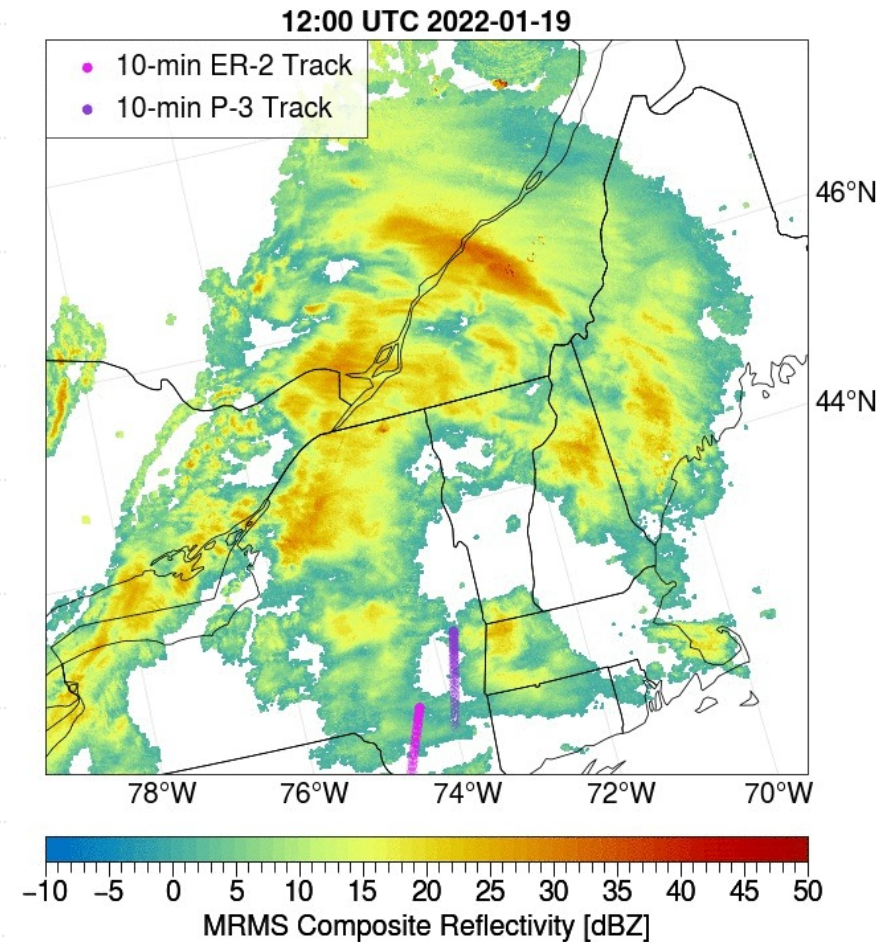
- 14 January: Cyclone over Cape Cod
- 17 January: cyclone upstate NY and Canada
- 19 January: Alberta Clipper in Canada
- 29 January: Nor'easter Plymouth MA and southern ME
- 03 February: Broad frontal band midwest
- 04 February: Broad frontal band NE and NY
- 08 February: GPM overpass Gulf of Maine
- 13 February: GPM overpass offshore NJ
- 17 February: Deepening snowstorm Chicago, IL
- 19 February: Alberta Clipper, Quebec
- 25 February: Snow over upstate NY



= storms over WINTRE-MIX region

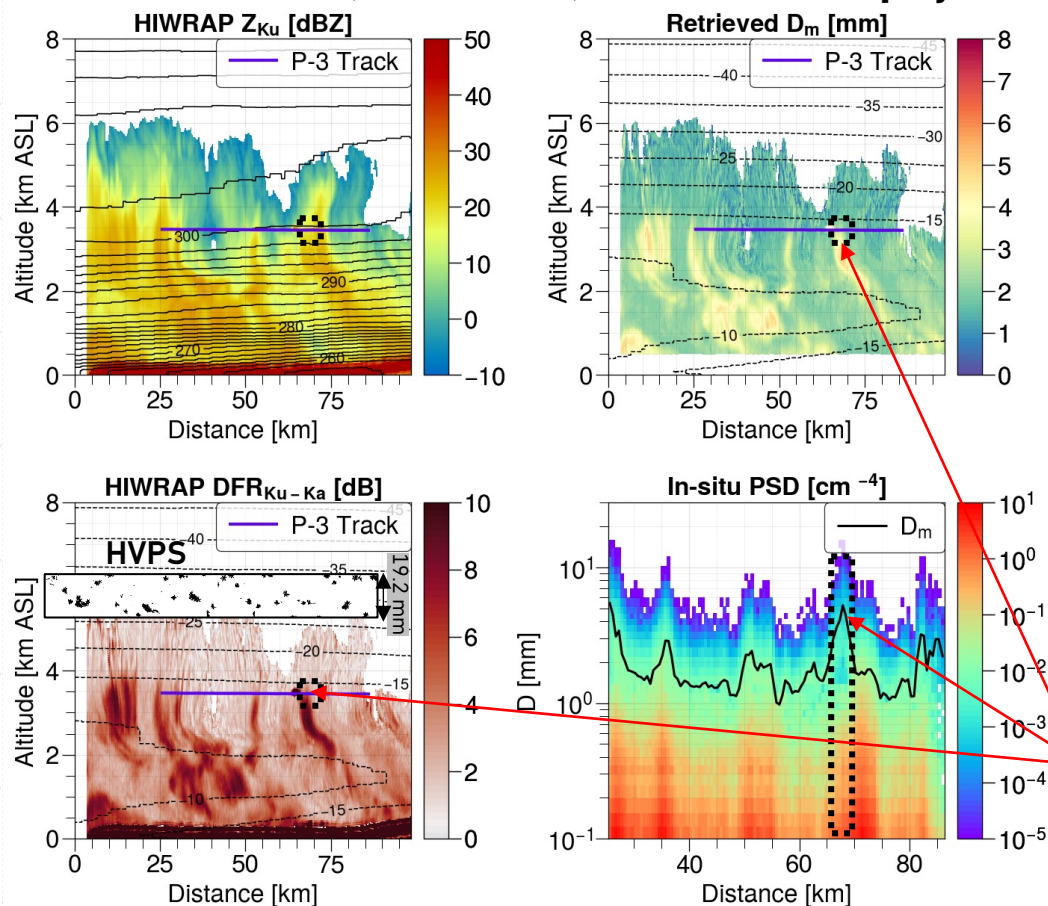
Alberta Clippers in WINTRE-MIX Domain

- Alberta clippers can produce localized regions of significant snowfall and present challenges for operational forecasting
- **Goals:** (1) Compare precipitation structures & microphysical properties between the clippers; (2) Relate to other mid-latitude cyclones sampled during IMPACTS

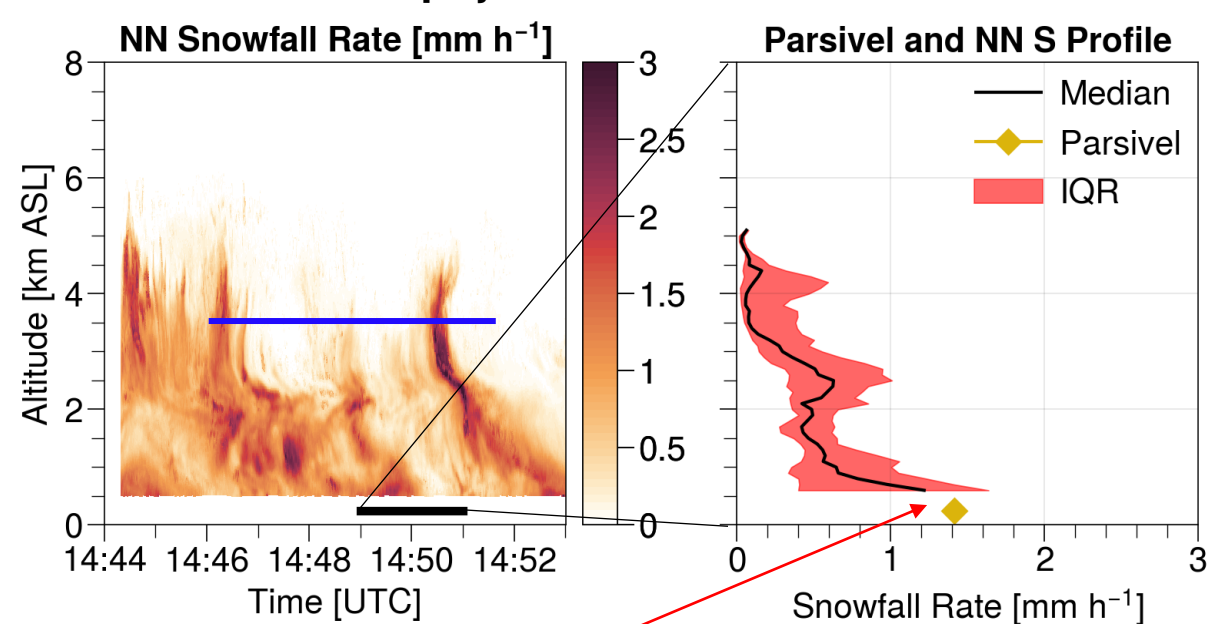


Synergy Between Airborne and Ground Instruments

Airborne Radar, Retrieval, In-Situ Microphysics

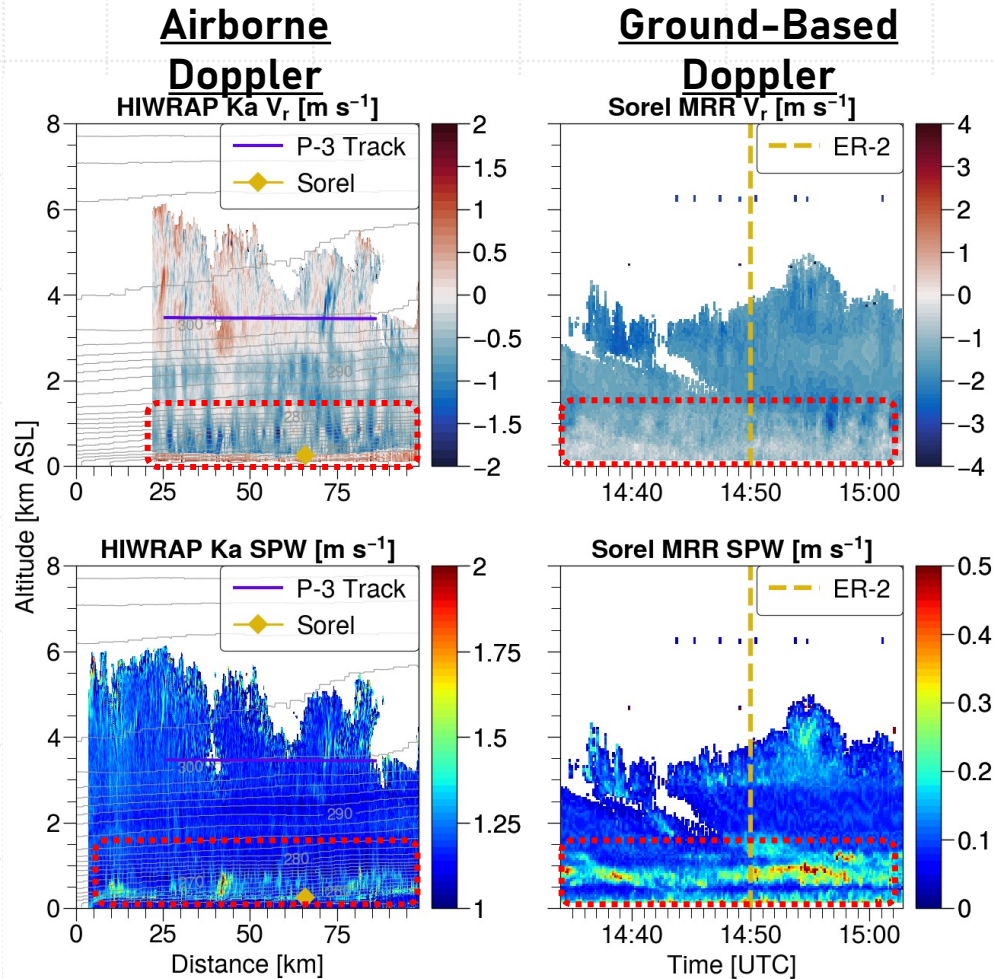


Retrieved Microphysics vs. Ground Measurements



Retrieved liquid-equivalent snowfall rates agree reasonably well with ground-based measurements
Enhanced aggregation in narrow region of high dual-frequency reflectivity ratio

Vertical Motions with ER-2 Radars and MRR-Pro



MRR provides complementary assessment of vertical motions within cloud

Turbulent motions within low-level stable layer related to stability

Summary of Clipper Analysis & Future Work

- 19 Jan 2022 Alberta clipper exhibited spatially variable precipitation structures and turbulent motions related to enhanced aggregation and IWC in the cloud and near the surface
- 19 Feb 2022 clipper consisted of less variable precipitation structures and smaller D_m , lower IWC and Z
- Future Work:
 - (1) Further relate radar observations & retrieved properties to ground-based measurements
 - (2) Relate precipitation properties in clippers to snowbands

Funding: NASA grant 80NSSC19K0338

IMPACTS: Data availability

- Have Field Catalog: http://catalog.eol.ucar.edu/impacts_2022/
- ESPO website for IMPACTS: <https://espo.nasa.gov/impacts/>
- Data available on the GHRC NASA DAAC: <http://ghrc.nsstc.nasa.gov/> and doi: <http://dx.doi.org/10.5067/IMPACTS/DATA101>
- BAMS article on IMPACTS: McMurdie et al. 2022: Chasing Snowstorms: The Investigation of Microphysics and Precipitation for Atlantic Coast-threatening Snowstorms (IMPACTS) Campaign. *Bull. Amer. Meteor. Soc.*, **103**, E1243–E1269, <https://doi.org/10.1175/BAMS-D-20-0246.1>